agricultural research

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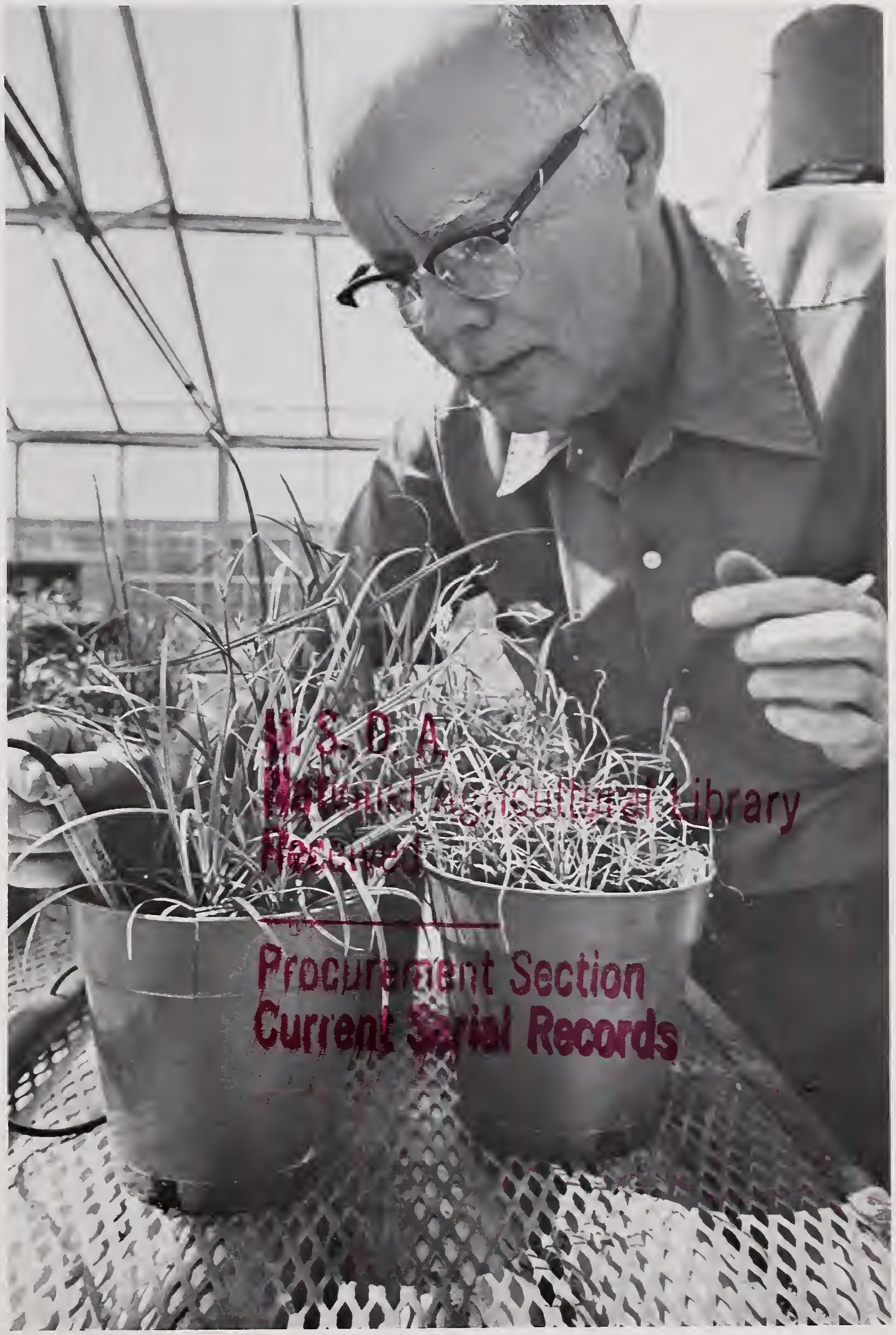

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July 1975/Vol. 24, No. 1

Enduring Gift

The corn that ripples across our land these summery days is an enduring gift from the Indian. Over the centuries, the first American took a wild grass and brought it to aristocratic rank among cultivated crops. The Indian lacked the white man's science, but patiently and with no known tools save the unaided eye, bare hands, imagination, and dedication he selected ever more desirable mutations and thereby domesticated a crop of value to the world. Paradoxically, this giant grass among the cereal bearers, if left alone in nature, becomes biologically helpless. Corn requires the nurture and protection of man to survive.

It was corn that sustained the Pilgrims at Plymouth when their wheat crops failed. Then friendly Indians taught the settlers how to plant, cultivate, and harvest this New World grain. So important a staple was corn in Colonial days that a law required dogs to be tied by a leg to prevent them from digging up the fish often planted for fertilizer in each corn hill. As the settlers pressed westward, they planted and improved the Indian's corn, and before long it became a basic feedstuff for a vast livestock industry.

But corn is much more than food for people or feed for livestock. Its versatile kernel touches our daily lives. We encounter corn products, often unknowingly, in the shoes and clothing we wear, the paper we write on, the rug on our floor, in our medicine chest, the car we drive, indeed in a multitude of ways. For ARS scientists and their colleagues have turned the organic raw material of corn into many products of industry. Even so, science has only begun to exploit the possibilities of the starch granule.

Years earlier, ARS joined the States in a unified effort to disseminate the latest findings on corn production research. Such mutuality enables each State to share knowledge with its neighbors and to draw on Federal research resources. It was this strategy that largely helped the rapid development and acceptance of hybrid corn.

What of the future? Perhaps the most ambitious work underway centers on varieties containing the mutant gene opaque–2. Problems remain to be solved involving yield, disease, and milling quality. However, the increases in lysine content brought about by the opaque–2 gene could make the protein of corn as nutritious as that of milk. In the world struggle against hunger, such an achievement—especially for the corn-eating peoples of Latin America and Africa—would give an even deeper meaning to the Indian word for corn, "that which sustains life."

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COVER: ARS entomologist Kenneth E. Frick compares two purple nutsedge plants in the research greenhouse. The injured plant on the right had three larvae of the nutsedge moth applied per shoot, 10 and 17 days previously. The healthy plant was exposed to no larvae at all (0475X323–10). Article begins on page 3.

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Dissection of a nutsedge stem exposes a Bactra verutana *larva feeding on a basal bulb of the plant. Scientists are rearing the tiny moth larvae in efforts to find a biological control agent against purple nutsedge (0475X326-26).*

Biological weapon against purple nutsedge

SUCCESSFUL culture studies, including an artificial diet to mass-rear predatory larvae, may help win the battle against purple nutsedge.

Found in California, Arizona, and throughout the southeast from Texas to Virginia, purple nutsedge rates among the top 10 most undesirable weeds in the United States, and costs millions of dollars in losses, and damages millions of acres of crop lands, gardens, and flower beds. Presently controlled only by extensive plowing and costly chemicals, the nutsedge is a prime candidate for biological control.

A small native moth, *Bactra verutana*, appears to be the most promising of 18 insect species found feeding on purple nutsedge at Stoneville, Miss. This widespread species is reported from the Gulf States to California, and in Cuba, Panama, and South America. Only small numbers overwinter, however, and they increase slowly in relation to plant growth. Thus the *Bactra* are normally ineffective in the field as a biological control agent. There is, however, a way to change nature's minus to a plus.

At the Southern Weed Science Laboratory in Stoneville, ARS entomologist Kenneth E. Frick found that purple nutsedge and yellow nutsedge, the other weedy host plant of *Bactra*, cause the greatest damage during the first few weeks of crop growth: for example, the first 6 weeks in cotton. The answer to effective suppression lies in early-season releases of *Bactra verutana*—in May and June while the crop is emerging.

In studies at the Cotton Research Station at Shafter, Calif., ARS plant physiologist Paul E. Keeley and agronomist John H. Miller report that *Bactra verutana* becomes numerous in early July. Dr. Frick and his colleagues have

found that *Bactra* becomes plentiful in the South early in August, about 4 months after the nutsedges begin to grow.

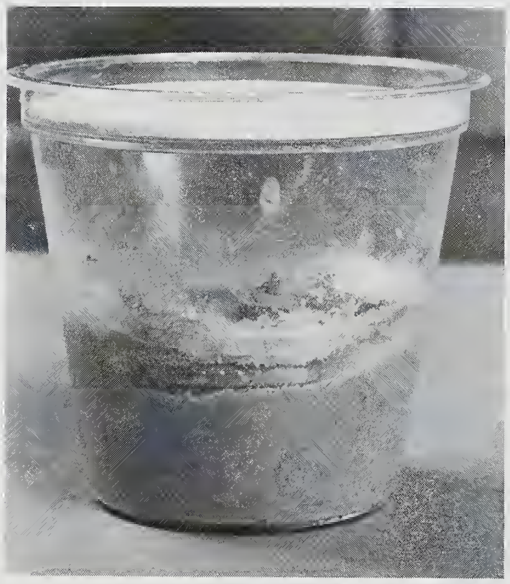
"Periodic massive releases of the insect into the fields could be highly effective if we initiate them early enough. Successive releases are necessary to get the new shoots that continually sprout. We need to infest every single nutsedge shoot," Dr. Frick said.

Simultaneous and independent diet and culture studies on *Bactra verutana* were begun at the Western Insects Affecting Man and Animals Laboratory at Fresno, Calif., and at Stoneville. The California study was directed by ARS entomologist Harry G. Davis as part of the graduate studies of Edwin E. Sieckert at California State University, Fresno.

After five generations, the California colony was terminated. The Stoneville colony was maintained for 33 months during which period 35 generations were reared, each of 28 days duration.

The key to mass rearing is a successful diet. Most important, the artificial diet must nourish insects so that they are comparable to field-collected insects in weight, longevity, mating, and fecundity. Research technician Clemente Garcia, Jr., and Dr. Frick produced such insects by modifying a wheat germ diet previously used by investigators to rear the pink bollworm.

Among the 16 constituents of the Stoneville diet were milled purple nutsedge powder, agar, vitamin-free casein, sucrose, wheat germ, vitamin mixture, and mold inhibitors. The liquefied diet was poured into clear plastic cups where it cooled and solidified. Then the diet surface was scratched in a pattern of parallel furrows into which the small larvae could crawl. Mold destroyed the diet in less than 4 percent of the cups. This success was attributed to rinsing the eggs and substrates in 4 percent formalin solution prior to larval hatch.



***Top:** The larvae are raised in small cups on a special diet. Before they are placed in the cups, the surface of the diet material must be scratched so the larvae will be able to feed on it (0475X324–15).*
***Above:** A nearly mature larva feeds on the diet material in one of the cups (0475X322–18). **Right:** Dr. Frick examines diet cups in the incubator that holds the living colony. The larvae remain in the colony/incubator for 3 weeks, when they emerge as adult moths (0475X325–23).*

The oviposition (egg-laying) cages were ½-gallon paper buckets with a circular hole punched on the side for the feeding vial containing a 10-percent-honey/10-percent-sugar solution. For oviposition, researchers used a bouquet of purple nutsedge supported with a ball of wet cotton in a plastic cup for half of the cages or a piece of accordion-pleated aluminum foil and a strip of saran wrap that were draped from a wire tied across the top of the other half of the buckets.

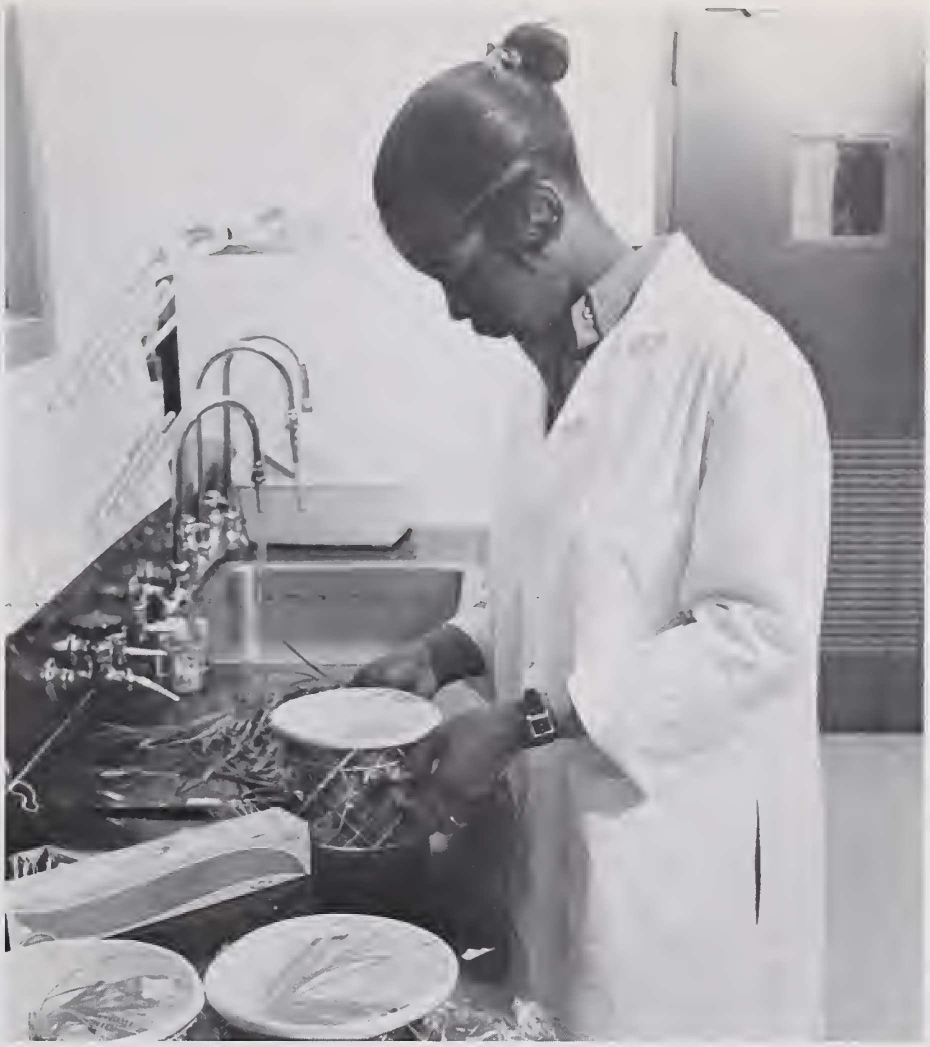
Egg laying, begun 2 days after adult emergence, resulted in as many as 400 to 500 eggs on a single shoot or on the aluminum foil and saran wrap. In the field, the greatest number of eggs found on a shoot was 23.

In three greenhouse tests, caged 2-week-old purple nutsedge shoots were infested with a single application of two or five newly hatched larvae per shoot of the 15th, 18th, or 26th generation. Two larvae killed 33 to 48 percent and five larvae 72 to 83 percent of the shoots, respectively. Under more natural conditions in field cages, a single infestation of two newly hatched 33rd generation larvae per shoot, applied to shoots 3 inches tall, killed or injured 18 percent of the shoots in 30 days and 70 percent in 60 days. Also, the weight of plant material produced above the soil surface was reduced by 50 percent after 60 days.

"Reared for 35 generations in the laboratory, the insect could have lost its natural ability to attack the host plants," Dr. Frick said, "but our *Bactra* remained vigorous."

The retention of typical field behavior in the insects apparently resulted from the use of milled purple nutsedge powder in the diet, the use of fresh purple nutsedge leaves as the ovipositional substrate in about half of the cages, and the short feeding period during which many newly hatched larvae fed on the leaves provided for oviposition.

With sufficient *Bactra* and the use of timely releases in the field, one of the "world's worst" could lose its title. □



Above: *Research assistant Fannie M. Williams prepares oviposition cages to receive adult moths. The cages contain nutsedge leaves on which the adults will lay eggs during their 5-day stay. A wick saturated with honey solution is added for food (0475X323–30).* ***Below:*** *Miss Williams infests each diet cup with eight larvae. Only five of the eight usually live (0475X325–6).*

Watching the sentinels

PERIODIC MONITORING of a few in-herd "sentinel" pigs can alert the practicing veterinarian to influenza-like illness before the occurrence of losses in young pigs.

Supportive treatment that may prevent death losses in young pigs should be initiated as soon as symptoms such as coughing and labored breathing are noticed, ARS microbiologist Eugene C. Pirtle points out. Swine influenza is not always readily differentiated from other diseases by outward signs. But infected animals can be identified by laboratory tests.

Swine influenza, commonly known as "hog flu," strikes suddenly, usually occurs in fall and winter, normally involves all of the susceptible animals within a herd, and subsides after a few days. The illness causes weight loss, reduced gains, and occasionally, death. No effective preventive measures are available.

Collecting blood samples for antibody tests and obtaining nasal swabs periodically on all animals would be impractical in herds of several hundred to several thousand pigs. Since an entire herd is usually affected, Dr. Pirtle evaluated the use of representative, or "sentinel" pigs in surveillance for influenza-like illness.

Dr. Pirtle, stationed at the National Animal Disease Center, Ames, Iowa, conducted the study in five Iowa feeder herds with a total of about 7,000 pigs. Veterinarians in large-animal practice assisted him in locating herds in which signs of swine influenza had not been reported in the fall months before the study.

On the first visit to each farm, Dr. Pirtle obtained nasal swabs for isolation of swine influenza virus, as well as blood samples for use in hemagglutination-inhibition tests from each of 20 "sentinel" pigs.

Dr. Pirtle took second blood samples from 6 of the "sentinel" pigs in each herd for hemagglutination-inhibition tests 3 weeks later if the virus was isolated, or 6 weeks later if it was not. The hemagglutination-inhibition test detects specific antibodies to the virus within 2 to 3 weeks after initial infection.

Dr. Pirtle chose "sentinel" pigs weighing 50 to 60 pounds, or 9 to 10 weeks old, because they should no longer be protected by antibody passively acquired from the sows. These pigs should be susceptible to infection and are likely to remain in the herd until they reach market weight.

Typical signs of swine influenza were seen in Herds 1 and 2 after these herds were selected for surveillance, but approximately 48 hours before the first scheduled visit. Diagnosis was confirmed directly by virus isolation and indirectly by a rise in specific antibody between the first and second visits.

Tests made after the first visit to Herd 3 indicated that it had previously been infected, even though signs of illness were not reported. Antibody was detected, although the virus was not isolated. Antibody was still present in low levels in serum samples collected 6 weeks later.

Herds 4 and 5 showed no signs of illness during the 6-week surveillance, virus was not isolated, nor were measurable levels of antibody detected.

Had either of these herds become infected with the virus in the first 4 weeks of surveillance, Dr. Pirtle says that specific antibody should have been detected in blood samples taken at the second visit. □

Byproducts

From the uni-flow filter, the effluent from the plant is pumped through the newly developed bark column where traces of soluble lead are removed (0375X295–9).

Left: At the lead battery plant, Dr. Randall and Mr. Hautala compare the clean end-product against the original effluent. Behind them is the uni-flow filter used to remove insoluble iron and lead from the wastes (0375X296–12). ***Below:*** *Back in the laboratory, Dr. Waiss checks fraction samples of the waste water for final analysis (0375X291–22A).*

scavenge metal pollutants

COPPER, lead, cadmium, chromium, and mercury are the major heavy metals which present a potential danger in the waste streams of industry.

Even small quantities of these toxic metals kill and contaminate fish and make water unfit for consumption or further industrial use. Many mining and manufacturing operations may be shut down unless they are able to meet new Federal and local standards that regulate the amount of pollutants a plant may release into streams and lakes.

To economically remove heavy metals from dilute waste streams, ARS chemical engineer John M. Randall and chemists Anthony C. Waiss and Earl Hautala, at the Western Regional Research Center, Berkeley, Calif., have developed a process which employs agricultural wastes or byproducts.

The metals are scavenged from dilute waste water by tree bark, walnut expeller meals, and other tannin-containing agricultural byproducts. The insoluble tannin in these byproducts provides active sites for binding the metallic ions whereby ions replace hydrogen in the tannin. Redwood bark, one of the best byproducts, binds up to 10 to 20 percent, by weight, of metallic ions.

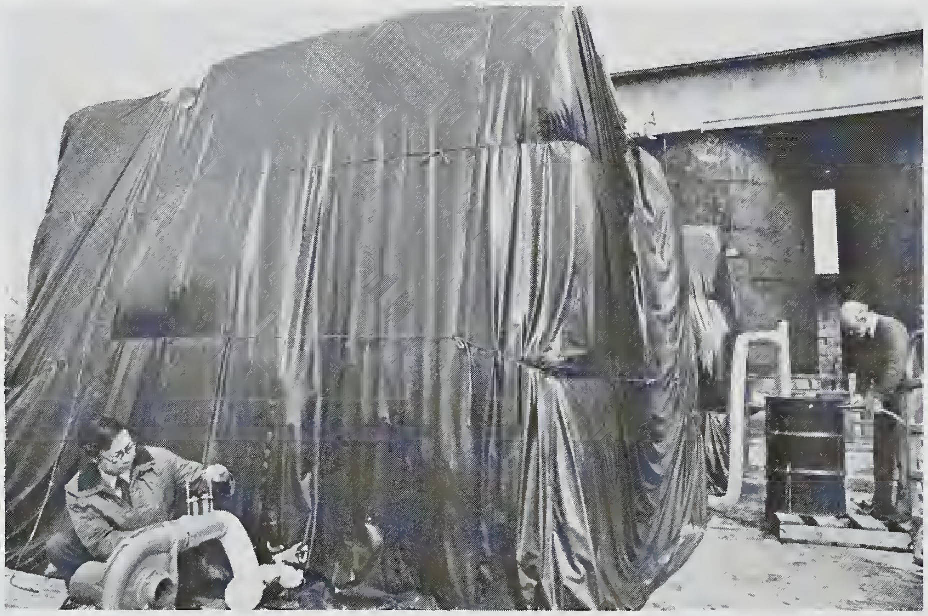
While most of today's processes for cleaning polluted water are effective in the partial removal of these metals, the ARS process is more efficient and economical in completing the removal to meet limits set by the Environmental Protection Agency. Mercury and cadmium can be reduced to below 0.01 parts per million (ppm), and lead and copper to below 0.1 ppm—both well below safety requirements.

An added benefit of the new process is that these metals can be easily reclaimed for reuse. The process is reversed by flushing the bed of byproduct with acid. The metals are displaced from their bonding sites and flow out through the system in a highly concentrated solution.

The scientists are presently operating a demonstration unit which removes lead and iron materials from the water effluent of a local lead battery plant. The untreated waste, containing insoluble iron, is filtered through a uni-flow filter (AGR. RES. July 1971, p. 3) before treatment on the bark column. The uni-flow filter, also developed at the Center, utilizes ordinary cotton hose which allows clear water to seep through the hoses while leaving the insoluble iron behind. This clear water is then piped to the bark column where soluble iron and lead are removed. Because this treated water is so free of contaminants, the plant can recycle the water back into the processing line, or discharge it directly to a sanitary sewer. □

Dr. Randall times the flow rate of the effluent as it leaves the uni-flow filter (0375X296–8).

Above: Dr. Waiss tosses a handful of ammonia-treated straw to cattle in the experimental feeding trial. Pellets and compacted material formed by extrusion of treated straw are also being tested as possible feed for cattle (0375X294–21). ***Below:*** In one method of treating the straw, Dr. Waiss and chemist Alan Goodban prepare to remove ammonia from baled straw. The straw was soaked with a 20–25 percent solution of ammonia and allowed to stand for 30 days (0375X294–6).



STRAW:

With burning regulations becoming more stringent every year, farmers and ranchers find it increasingly difficult to dispose of straws. Incorporating straw into the soil is not feasible in many cases; burning it causes air pollution, and wastes a potentially usable byproduct.

Straw is the world's largest source of agricultural carbohydrate; for every pound of grain produced, about 1 pound of straw is produced and must be disposed of. One approach toward disposal is feeding straw to livestock, a method of limited value, until recently.

Historically, rice, wheat, and barley straws, and corn cobs make poor feedstuffs because lignin, silica, or a combination of the two, so encrust the energy-rich carbohydrates, cellulose and hemicellulose, that the microbes in ruminant animals' stomachs cannot break them down to release energy. The answer to this problem is some treatment that opens up the fibers enough to permit increased digestion to occur in the animal's rumen.

As early as 1965, researchers at the Western Regional Research Center, Berkeley, Calif., were looking for ways to treat straw and similar materials to increase their usefulness in feeds for cattle and sheep. Now, ARS chemists

Right: In another method, the straw is compacted under high pressure and extruded by a special L-shaped extruder designed by engineers at the Berkeley Laboratory. Technician Peter F. Hanni shovels the compacted material into barrels for storage (0375X291–11A).
Middle and far right: Equipment foreman Kenneth V. Smith and technician Gene A. Whitaker examine the straw mixture before it goes into the pellet mill (0375X293–34) and after the pellets are formed (0375X293–36).

from trash to productive feed

George O. Kohler, Howard G. Walker, and Anthony C. Waiss, who experimented with many combinations of chemical and physical treatments, have selected two processing systems as the most promising. Large-scale preparation of treated straws in quantities sufficient for animal feeding trials resulted from pilot scale processing studies of the two systems conducted by engineers Robert P. Graham and Marcus R. Hart.

In one system, ground straw is treated with sodium hydroxide ($NaOH$). The $NaOH$ is sprayed on the straw as a 30 to 50 percent solution so that about 4 pounds are applied per 100 pounds of straw. This mixture is then either pelleted in a mill, or put through a screw extruder—much like a meat grinder—designed by the Center's engineers. Both the pelleted and extruded forms of this product are reasonably dense, facilitating handling and transportation. The products are fairly dry—11 to 18 percent moisture—and, therefore, do not require costly dehydration for safe storage.

The second processing system involves soaking baled straw with a 20 to 25 percent solution of ammonia in water so that each 100 pounds of straw is treated with about 5 pounds of ammonia. Stacks of treated bales are enclosed in plastic sheeting and allowed to stand at least 30 days before dehydration. The "stacks" are vented, and excess ammonia is safely trapped to prevent air pollution.

In a preliminary 63-day trial, sheep which were fed rice straw treated by these methods gained about ⅓ pound per day or approximately 50 percent more than those fed untreated straw. This compares favorably with alfalfa-fed sheep. The treated ration contained 72 percent straw, 10 percent alfalfa hay, 6 percent barley, 9.8 percent cottonseed meal, 1 percent urea, and small amounts of dicalcium phosphate, trace mineral salt, and vitamin A. This trial was conducted in cooperation with Dr. William Garrett at the University of California, Davis.

More recently, a 56-day beef cattle feeding trial was carried out at Davis. In this experiment, the cattle gained over 3 pounds per day on a ration containing up to 60 percent treated rice or barley straw. "We are very encouraged by the results we're getting," says Dr. Walker. "Our next step is a 100-head beef feeding trial at Davis which will run for about 150 days. We hope to get the same results in this longer trial."

Dr. Kohler says, "The increased gains are due to increased digestibility of cellulose and increased consumption of the treated straw rations. We observed no animal health problems with any of the treated straw rations.

"The project is important not only because of the pollution problem that straw burning causes, but also because of shortages and increasing prices of grains. By replacing grains as much as possible in cattle and sheep rations, we should be able to produce meat cheaper.

"The world is facing a shortage of energy and arable land. This makes it essential that we make more efficient use of crops in which large expenditures of energy have already been made. It is especially important that we develop ruminant feeds from materials that are unsuitable for human consumption," Dr. Kohler says.

In the past few years, other agricultural residues and methods for treating them have been evaluated. Among them are treatments for corn cobs, conducted in cooperation with the University of Nebraska; for sugarcane bagasse and pineapple field trash, in cooperation with the University of Hawaii; and for seed grass straw, conducted in cooperation with Oregon State University. Adoption of these processes will depend on economic and environmental pressures. □

National Seed Storage Laboratory Computerized

In the last 70 years, U.S. agriculture has lost forever over 50 varieties of clover for every variety still grown. Other irretrievable losses include 9 out of every 10 soybean accessions and 2 out of every 3 oat accessions.

The National Seed Storage Laboratory, Fort Collins, Colo., was built in 1958 in an effort to stop the loss of valuable germ plasm here and abroad (AGR. RES., Nov. 1971, p. 8).

Recently the laboratory transferred all of its information on about 90,000 different seed samples from cards to computer tape. So handled, the information is much more complete and up-to-date and can be retrieved in a matter of seconds.

Louis N. Bass, head of the laboratory, says, "With the information which is stored at USDA's new computer center here in Fort Collins, we'll be able to conduct more thorough multiple-characteristic searches for seeds. If a researcher requests alfalfa seed that is disease resistant, early maturing, and extremely winter hardy, it will take the computer only seconds to tell us where all the various seed samples are located. This will eliminate hours of manually searching records."

Along with information on plant characteristics, disease and insect resistance, and location, the computer also stores information on germination history, origin, and donor of each sample.

The laboratory can also use the computer to find those seeds that are due to be retested for germination. This is important in maintaining seed viability. If a seed, such as corn, has been stored for 5 years, the computer indicates at that time that new testing is needed.

Another use of the new computer records is for inventory requests. The laboratory frequently receives requests for a listing of all seeds of a certain species. In such cases, the computer provides a detailed printout of only those seeds that are requested.

The computer also keeps track of the quantity of each seed sample. When the inventory starts getting low, the staff is alerted to begin acquiring more seed. □

Resistant Indian wheats hold promising future

When seed from certain resistant varieties of spring wheat is harvested this summer from South Dakota State University nurseries at Brookings, ARS scientists hope to have sufficient stock for further research. And for good reason: these wheats are resistant in varying degrees to either or both the rice weevil and the lesser grain borer, two major pests of stored grain.

The resistant wheats are from the world collection at the Indian Agricultural Research Institute, New Delhi, where, under a 5-year ARS grant, scientists screened nearly 2,000 varieties for resistance. Of 1,536 tested against the rice weevil, 53 were found resistant. Of 1,256 tested against the lesser grain borer, 48 were resistant. Seven varieties proved resistant to both pests.

The varieties studied under this grant are not usually found in the United States. ARS-cooperating scientist Gailen D. White, Manhattan, Kans., says, "If some way can be found to transfer the resistance to wheats grown in this country, the value to U.S. agriculture would be considerable."

Preliminary rice weevil-resistance tests on some of these varieties were conducted by ARS research entomologist H. Paul Boles, Manhattan. "Field control is the first line of defense against insect damage. However, the ultimate value of a harvest is greatly influenced by the efficiency of its protection during storage," he says.

Using Kalyan Sona, a Mexican variety now widely grown in India, and two varieties of Indian parentage—PI 322275 and PI 323343—Dr. Boles ran tests in four replications, assigning 250 kernels for each replication. For comparison checks, he used Omar, Gaines, and O. A. Vogel's (selection 101)—three representative U.S. varieties.

Preliminary data from Dr. Boles' experiments indicate that Kalyan Sona and the two Indian wheats are highly tolerant to rice weevils—capable of resisting more than average insect pressure. In the upper range, kernels of PI 323343 developed only about 4 percent insect infestation. The comparison checks proved highly susceptible, developing approximately 90 to 160 percent infestation.

As a result of the Indian project, 33 resistant wheat varieties are now in the Small Grains Collection, Beltsville, Md., where they are catalogued as Plant Introduction (PI) numbers 338413 through 338446. Seed planted at Brookings came from this collection. Also in the collection, among the varieties resistant to both rice weevil and lesser grain borer, are PI 322249 and Kalyan Sona (PI 345940), a high yielding, dwarf variety developed by the International Maize and Wheat Improvement Center, Mexico.

The Indian research was directed by Dr. S. Pradhan, principal investigator, and his associates: Dr. S. R. Singh, Dr. S. K. Bhatia, and Dr. S. P. Kohli. □

Long-range dispersal of the boll weevil

The Guinness Book of World Records may not list this one, but two boll weevils in Mississippi have chalked up an all-time travel record of 45 miles in approximately 11 and 27 days.

This distance is significant to entomologists planning future practical eradication efforts. The capability of the weevil for long range movement is still being determined in detailed dispersal studies.

Dispersal may occur in any season but is most prominent when over-wintered adults move from hibernation sites in forest litter into cotton fields, and when dense, growing populations of weevils migrate late in the season to seek uninfested cotton. In general, movement of weevils begins early in spring, decreases during midsummer, and increases again to a high level in August and September.

Sometimes called the most costly insect in the history of American agriculture, *Anthonomus grandis* Boheman is a winged, voracious, paripatetic cotton pest causing losses in U.S. cotton production at an average of $200 to $300 million each year.

"The boll weevil is currently in the limelight as a super pest of cotton, but results obtained in the Pilot Boll Weevil Eradication Experiment in 1971–73 indicate that it may be possible to eradicate it from the United States in the future," says entomologist William H. Cross.

As a part of a combination of eradication techniques in large-scale field trials, ARS entomologists William L. Johnson, William L. McGovern, Joe E. Leggett, and Mississippi State University entomologist Henry C. Mitchell, with Dr. Cross, have conducted dispersal studies over a period of 5 years. In selected counties in Mississippi, Louisiana, and Alabama researchers released marked and color-coded insects, using a variety of boll weevil traps for recapture.

In the first studies in 1970 at the Boll Weevil Research Laboratory, Mississippi State, Miss., native overwintered boll weevils were captured, individually coded and released in forest litter at predetermined sites 10 to 15 feet apart.

Subsequently, a grid of oblique-funnel traps (a uniform arrangement of traps spread out over the area) were baited twice a week with live male laboratory-reared boll weevils. The oblique-funnel trap is oblong, made of plexiglas, and has five screen funnels pointed up to the source of bait—live males or the synthetic sex attractant grandlure. Traps were arranged in concentric circles at 1/8-mile intervals to a distance of 1/2 mile from the release site for recapture of the released weevils.

An adjacent 6 1/2-acre field of cotton was the site of releases of 4,241 weevils captured by running a "bugcatcher," a large combination vacuum-and-blower, tractor-mounted machine that collects the weevils in bags from rows of cotton.

These weevils were marked with spots of paint on each elytron, wings that protect the posterior pair of functional wings, and released the same night on a center of circles arranged with wing traps baited with live male weevils. Located at 1-mile intervals to a distance of 8 miles with one trap to a location, the wing traps were coated with Stikem, a commercial substance which catches and holds the insects.

Bugcatcher samples were taken in nearby cotton fields; 128,500 weevils were captured, mass sprayed with daylight fluorescent paints, and released the same night. Distances traveled varied from 1/4 mile to slightly over 10 miles.

In 1971 boll weevils were released and dispersal measured from several fields to 1/2-acre cotton plots and a grid of grandlure-baited Leggett traps. Briefly, a Leggett trap is constructed with an inverted papier-mache floral liner, painted saturn yellow, and capped with a screen cone. In the apex of the cone is a small hole that opens into a plastic box where the weevils are trapped. The complete trap is mounted on a stake 3 to 4 feet above the ground. In this study, 152,762 boll weevils were released and 224 weevils were recovered at distances from 1 to 24 miles.

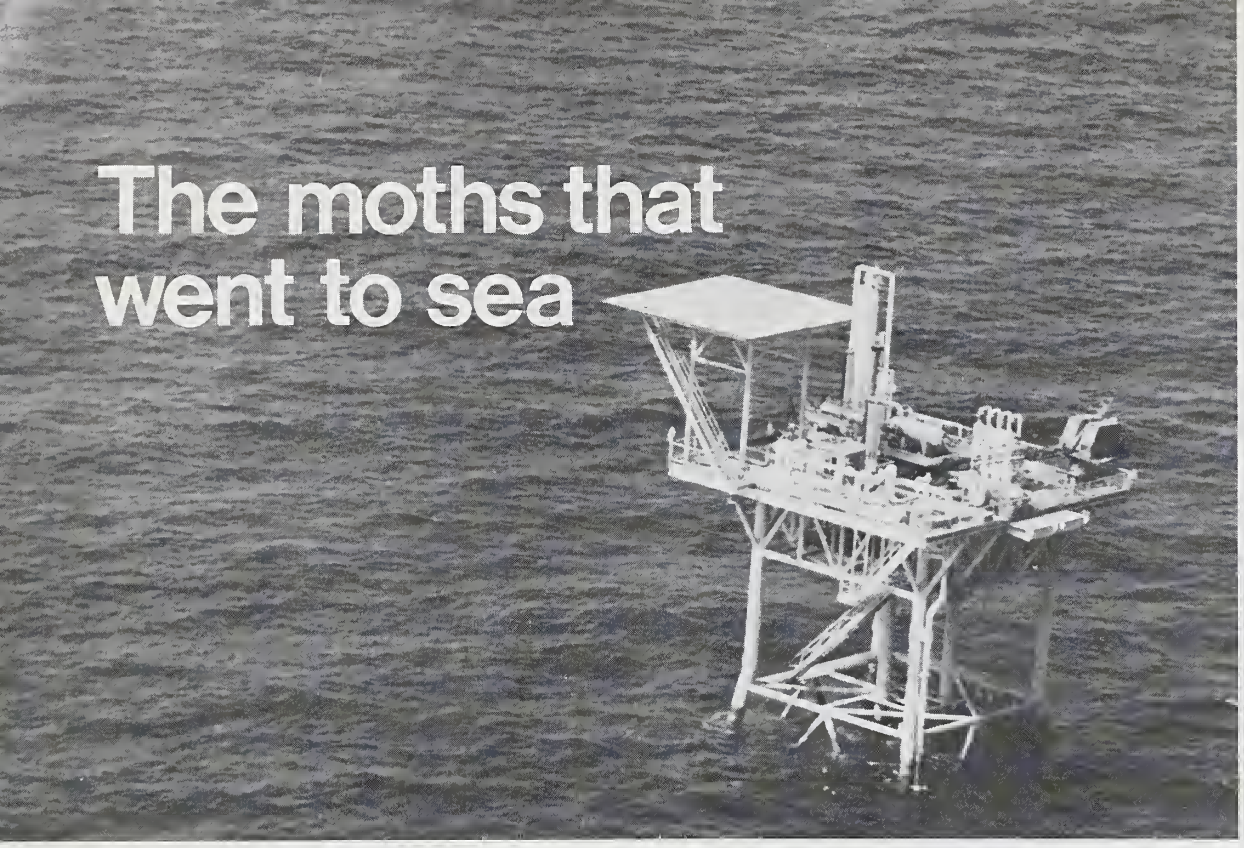
In 1972 additional marked weevils were released in three small fields. Leggett trap lines were run inward to 60 miles toward the core of the test area of the Pilot Boll Weevil eradication Experiment, and also outward in an opposite direction for 30 miles. The eradication test area was centered in south Mississippi, southeast Louisiana, and southwest Alabama.

In 1973, again with Leggett traps, 16 weevils were recovered 5 to 33 miles away, one traveling 33 miles in 31 days.

In 1974, 275 sites with three Leggett traps each were located in a 50-mile grid. A total of 122,748 trap-caught and 39,280 field-caught weevils were released. Eighty-six were recaptured at distances from 5 to 45 miles from the release point in Oktibbeha County, Miss.

Results of the comprehensive studies should aid immensely in future planning of the eradication program because they will serve as a basis for determining the width of the buffer between the zone where treatment has been completed and the next zone where treatment is to begin. Maintenance of the buffer would insure that reinfestations did not occur through migration into the completed treatment zones. ☐

The moths that went to sea



The corn earworm—*Heliothis zea* (Boddie)—may not win any popularity contests, but it is a strong contender as an Olympic champion at "free flight." This moth can fly nonstop across 100 miles of water.

To prove it, two ARS entomologists equipped traps with ultraviolet lamps and placed them on unmanned oil drilling platforms 100 miles offshore in the Gulf of Mexico; the corn earworm, with other crop-destructive *Lepidoptera*, found the mark.

In an experiment designed to test the flight range of various pest insect species, battery-operated, black-light insect traps were installed 20, 46, 66, and 100 miles offshore between Morgan City and Jeanerette, La. The traps captured more than 100 species of adult insects from seven different orders.

Their common names make a shopping list in reverse for vegetable lovers: beet armyworm, cabbage looper, velvet bean caterpillar, and corn earworm. ARS entomologist Robert D. Jackson, U.S. Sugarcane Laboratory, Houma, La., also cites the fall armyworm, large cotton leafworm, black cutworm, tobacco budworm, and the granulate cutworm as species captured.

At the Southern Grain Insects Laboratory, Tifton, Ga., entomologist Alton N. Sparks reports that all four traps captured corn earwarms—27 at 20 miles, 16 at 46 miles, 8 at 66 miles, and 3 at 100 miles.

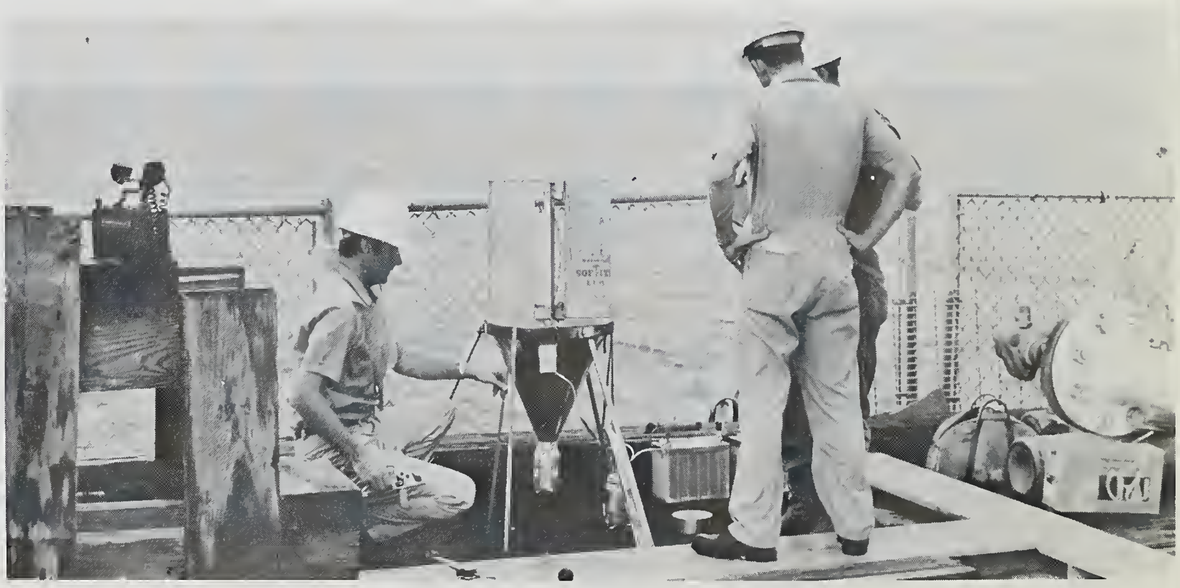
The distance covered by insects in flight has long been studied by entomologists. Many eradication experiments have been conducted with the assumption that isolation of a few miles was sufficient. "We discovered in 1972 that the corn earworm could be captured in light traps on a television tower from 23 ft. to 1,047 ft. above ground," said Dr. Sparks. "Trapping records led us to believe that corn earworms were capable of attaining controlled flight altitudes in excess of 1,000 ft. throughout the normal flight season." Controlled flight is flight controlled by the insect, but which may be assisted by the winds. "We also found that the insect migrated a distance of at least 16 miles in 1 night and at least 45 miles in 1 to 4 days."

This flight capability is particularly important because *Heliothis zea* is a prime target for suppression.

Former ARS entomologist Clinton L. Allen, currently a commercial helicopter pilot at Lafayette, La., observed the presence of insects many miles out into the Gulf. Dr. Sparks and Dr. Jackson, using a leased helicopter from the U.S. Geological Survey, followed this "tip" with a study to determine both the species of the insects and the distance from the land the insects had traveled.

The researchers placed funnel-type traps 15 inches in diameter and 18 inches high on 4 unmanned oil platforms in the Eugene Island area of the Gulf, 30 miles wide and extending 150 miles south of the Louisiana coast.

A 1-quart collecting container was placed below the funnel; one-half was filled with diesel oil or formalin solution to kill the captured insects. A 15-watt blacklight lamp was secured in the center of four baffles. The lamps were energized by a 12-volt battery controlled by a photocell to operate be-



Right: *Entomologist Robert D. Jackson inspects a light trap on one of the unmanned oil platforms in the Gulf of Mexico (BN–43812). Scientists placed traps on platforms like this and the one above (BN–43810) to determine the flight range of various insects.*

In another related study scientists trapped high-flying corn earworm moths in this light trap on a television tower 1,047 feet above Pelham, Ga. (BN–43811).

tween sunset and sunrise. All traps were placed on the platforms for 6 weeks during the fall. Cooperating oil field personnel on adjacent manned platforms exchanged and charged the batteries and changed the collecting containers.

Entomologists Sparks and Jackson concluded that the majority of captured moths were traveling on a southbound cool front. "Regardless of that," said Dr. Sparks, "these travels must have been controlled flights. Rig locations are clumped around salt domes on the Gulf floor—we could fly 10 minutes by helicopter without sighting a rig—and light traps are generally ineffective over a long distance."

Why conduct the experiment 100 miles over water?

The trapping experiment clearly indicates that larger isolation areas may be required for successful eradication programs. "We know, for instance, that the insects in this experiment did not originate 10 miles away," said Dr. Jackson. 'There's no in-between. And they were still able to react to stimuli—such as light—after flying many miles."

Destructive insects like the corn earworm, the soybean looper, and the cabbage looper can reinfest areas from much greater distances than researchers had previously assumed. □

Carpet beetle also likes wool-synthetic fibers

BLACK CARPET BEETLES are highly-destructive wool-consuming fabric pests and they seldom stick to carpets. As any householder-consumer knows, the carpet beetle's menu also includes such woolens as coats, pants, skirts, shirts, and scarves. Wisely, most homemakers mothproof their woolens. Unwisely, they may overlook entrees equally appetizing to the carpet beetle.

Says ARS entomologist, Roy E. Bry, "Feeding tests with nine fabric samples show that carpet beetle larvae feed heavily on all wool-synthetic blends. The most attractive was a fabric containing 50-percent wool, 20-percent polyester fiber, 19-percent nylon, and 11-percent cotton."

In feeding studies at the Stored-Product Insects Research and Development Laboratory in Savannah, Ga., Mr. Bry and colleagues exposed eight wool-synthetic blend fabrics to larvae of the black carpet beetle, *Attagenus megatoma* (F.) Standard 100-percent wool mothproofing test fabric was used for comparison. Woven and finished by three woolen mills, the eight blend fabrics were purchased in Savannah stores and chosen as representative of various fabric weights and weaves. There were duplications as well as variations in the wool content.

Using insects from laboratory cultures, the amount of feeding was based on a commonly used excrement weight procedure. Each of four 2.5 by 5.1 centimeter samples cut from each fabric was tested for its susceptibility to larval feeding by exposing it in an open petri dish to 10 larvae for 14 days. Replicated three times, the tests were made in a darkened cabinet in a room maintained at about 27° C.—80° F.—and 60 percent relative humidity.

Damage to the samples varied, depending on the type of blend. The larvae displayed interesting preferences; when the warp yarns were made of wool and the filling yarns of a synthetic fiber, or vice versa, the larvae ate the wool and left the man-made fibers alone.

When fabrics contained yarns made of a blend of wool and synthetic fibers, the larvae bit off pieces of the yarn and swallowed both the wool and fibers. Microscopic examination of the excrement showed that only the wool was digested and the synthetic or cellulosic fibers passed out of the digestive tract unchanged. The point for householders may be that the beetle will eat synthetic fibers whether they are "good for it" or not.

In standard feeding tests, heavy damage results if excrement weight is 1.50 milligrams (mg) or more per larva. In the Savannah tests, the weights varied from 1.96 mg (34-percent wool, 66-percent polyester) to a high 3.12 mg (50-percent wool, 50-percent polyester, nylon, and cotton). Polyester constituted the synthetic fiber content of the seven other fabrics. The weight from the 100-percent wool test fabric was 2.30 mg.

"Increased use of wool-synthetic blends may give the American housewife a false sense of security," says Mr. Bry, "but she should take the same precautions in protecting these garments as she takes in protecting all-wool fabrics." □

Flame retardant coming for cotton/polyester blends

A NEW FLAME retardant finish for fabrics made from blends of cotton and polyester has been developed by a team of scientists working at the Southern Regional Research Center in New Orleans.

Development of the new finish is timely because there is now no commercial finish for common cotton/polyester blends. However, there is a growing need for such a finish because recent amendments to the Flammable Fabrics Act of 1953 are resulting in stringent regulations.

For example, now there are stringent regulations for fire retardant finishes for children's sleepwear. ARS helped meet this need by developing several flame retardant finishes for various weights of all-cotton fabrics. These are in use by industry.

Next to be regulated probably will be dresses, shirts, and trousers, most of which are currently being made from fabric blends.

The new finish effectively imparts flame resistance to blends that contain 50-percent polyester. The finish remains effective through 50 home-type machine wash and dry cycles.

Starting point of the research was with a flame retardant which ARS chemists Darrell J. Donaldson, Floyd L. Normand, George L. Drake, Jr., and Wilson A. Reeves knew was a good one for the cotton component of the blend. The retardant is tetrakis(hydroxymethyl)phosphonium chloride reacted with urea or Thpc-urea for short.

They knew, too, that brominated compounds are effective flame retardants for polyester textiles. After a good bit of research, they settled on polyvinyl bromide (PVBr) emulsion for two reasons: (1) It proved compatible with the Thpc-urea, and (2) it has a high bromine content per molecule of compound.

Using a lightweight 50/50 cotton/polyester blend in laboratory research, the chemists wet the fabric with the Thpc-urea-PVBr solution to get a 90-percent wet pickup. The wet fabric is dried at 85° C., then heat treated at 160° C. for 1 to 1½ minutes. The fabric is then rinsed or washed to remove unreacted chemicals and dried.

The treated fabric retains a high percentage of its breaking strength, more than half of its tearing strength without employing a softener, and has a good "hand" or feel.

The treatment is not yet ready for commercial use because the treated fabric has a tendency to discolor slightly under some laundering conditions. However, the developers feel the problem can be corrected with additional research. □

No-till systems prove ideal on claypan soils

NO-TILL SYSTEMS for growing corn have proved ideal for claypan soil that is typical of much of the Midwest. By managing the soil with no tillage, ARS scientists minimized erosion, saved fuel, and produced more corn per acre than with conventional tillage.

The scientists showed that keeping a vegetative cover—crop residue or a living crop—on the soil surface throughout the year is a key to reducing soil loss. The study, conducted on a gently rolling land over a 4-year span, was cooperative with the Missouri Agricultural Experiment Station, Columbia.

"With no-till methods we produced 4 more bushels of corn per acre than by using conventional tillage, and we used less fuel," said ARS hydraulic engineer Herman G. Heinemann. "But more importantly, we held the average annual soil loss down to 0.6 tons per acre."

Mr. Heinemann and hydrologic technician Fred D. Whitaker also studied a no-plow system for growing corn. They cultivated plots once before planting and cultivated the corn for weed control. On these plots they grew about 13 more bushels per acre than they did with no-till methods, but they lost about 1.5 tons of soil through erosion. Average annual soil loss from conventionally-tilled plots was even greater—4.3 tons per acre.

On some of the no-till plots, the scientists removed corn as silage and drilled rye as a winter cover crop. Rye is normally seeded to provide pasture for livestock and to protect the soil.

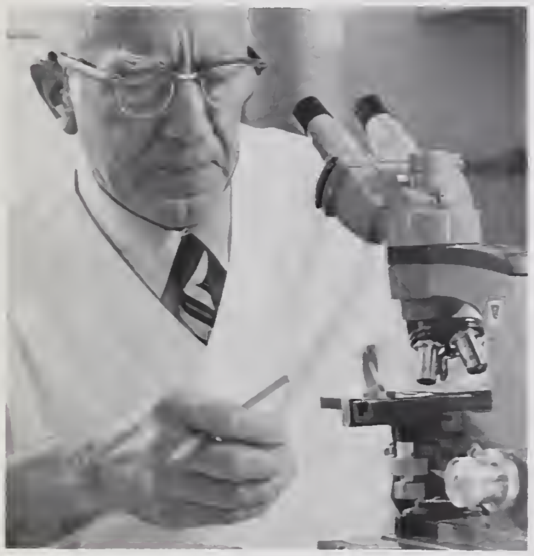
At corn planting time, the researchers killed the cover crop with a contact herbicide. The living rye had helped the soil to dry and warm up earlier in the spring than with stalk-residue cover. Later, the dead mulch reduced surface sealing of the soil and sustained high water infiltration rates. The conserved water helped counter midsummer droughts that often occur during a critical period of the corn crop's development.

Using the system just described is an especially good practice in the Midwest claypan area, Mr. Heinemann said. This area includes 10 million acres, mostly in Missouri, Illinois, and Kansas, but also in Nebraska, Oklahoma, and Iowa. A compact layer of subsoil, normally about 15 to 20 inches below the surface, restricts air and water movement and retards deep growth of plant roots.

During the studies, rainstorms that occurred soon after soil was tilled produced runoff with high concentrations of sediment. Runoff from no-till plots contained only an organic stain and very little sediment. The soil cover had dissipated the rainfall's energy, eliminating splash erosion, and reducing runoff erosion. □

SCIENTISTS HONORED

For their outstanding achievements, six individuals and two groups of ARS employees recently received Distinguished and Superior Service Awards. Secretary of Agriculture Earl L. Butz presented the awards at USDA's 29th annual awards ceremony last May 28 in Washington, D.C.



Recently retired research leader Ben R. Burmester (0673A1216–21).

Distinguished Service:

Dr. Ben R. Burmester (Retired), research leader; avian leukosis supervisory research biologist; and director of ARS' Regional Poultry Research Laboratory, East Lansing, Mich., for performing and directing research on virus diseases of poultry that has had a tremendous beneficial impact on the poultry industry.

Superior Service:

Dr. Walter A. Gentner, plant physiologist, Beltsville, Md., for contributing to the fight against drug abuse by developing agricultural techniques to control narcotic plants.

Dr. Richard Fairbanks Keeler, research chemist, Logan, Utah, for identifying teratogenic compounds from native range plants responsible for congenital deformities in livestock.

Dr. August E. Kehr, staff scientist, National Program Staff, Vegetables and Ornamentals, Beltsville, Md., for leadership and contributions to horticulture through research and administration of ARS responsibility for national and international agriculture.

Dr. William E. Larson, research leader, St. Paul, Minn., for research and leadership in developing soil physical principles to improve tillage practices, increase water intake into soils, and provide guidelines for using municipal sewage wastes.

Mary S. Peter, public information officer, Beltsville, Md., for creating a unique method of communicating how agricultural research can contribute to increased food production.

Boll Weevil Pheromone Development Group, Mississippi State, Miss., for discovering and pioneering the development of the boll weevil pheromone as a technique for detection, survey, suppression, or elimination of this pest. Headed by Dr. Theodore B. Davich, the group also included: Dr. William H. Cross, ARS; Dr. Richard C. Gueldner, ARS; Dr. D. D. Hardee, ARS; Dr. Paul A. Hedin, ARS; John C. Keller (deceased), ARS; Dr. James P. Minyard, Mississippi State University; Dr. Alonzo C. Thompson, ARS; and Dr. James H. Tumlinson III, ARS.

Whey-Soy Beverage Team, Philadelphia, Pa., for developing a nutritious whey-soy beverage that is used as a dry milk substitute in vital overseas feeding programs. Headed by Dr. Michael J. Pallansch, team members included: Dr. Locke F. Edmondson, ARS; Nicholas C. Aceto, ARS; Dr. Eugene J. Guy, ARS; Ms. Virginia H. Holsinger, ARS; Howard I. Sinnamon, ARS; Harold E. Vettel, ARS; Ms. Carol A. Sutton, ARS; Paul R. Crowley, ERS; and Byron L. Berntson, ERS. □

Rhizoctonia root rot resistance

INTRICATE BREEDING techniques and genetic studies have enabled scientists to produce sugarbeets that are 70- to 75-percent resistant to rhizoctonia root rot.

ARS plant geneticist Richard J. Hecker, Crops Research Laboratory, Fort Collins, Colo., foresees the breeding of a line that is completely resistant.

Rhizoctonia root rot annually destroys about 5 percent of the U.S. sugarbeet crop—a loss of about $25 million. The degree of loss in any one area may be affected by temperature, moisture, and soil type. Because the soil-borne fungus, *Rhizoctonia solani*, is present in most all soils, root rot could cause a total disaster for growers should the right combination of conditions occur at the same time. Currently, there are no effective chemicals to control the disease; cultural control by crop rotation is of limited effectiveness.

"After 3 years' research with actual field experiments we have discovered that achieving resistance to root rot is as hard as achieving increased yield in some crops. Both characteristics are controlled by more than one gene. If we can incorporate that last fraction of resistance into our sugarbeet lines, we will have completely resistant sugarbeets and thus increase overall yields without resorting to chemical control," Dr. Hecker says.

Rhizoctonia solani attacks a wide range of plants, including tomatoes, beans, and corn. In sugarbeets, it can cause early death of seedlings but, more importantly, it causes roots and crowns to rot on older plants. The fungus commonly invades sugarbeet roots near the soil junction or at the base of the petioles. Progression of the disease leads to partial or total rot of the crown and root, death of the leaves, and eventually death of the plant.

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AGRISEARCH NOTES

Kinks in corn breeding

SELECTING parent corn plants for such heritable traits as yield, insect resistance, and reduced lodging gives the corn breeder a task somewhat like measuring a wiggling snake for total length and for size of each loop—all at the same time.

The corn breeder's measuring stick—the selection index—is a tool applied over several cycles of selection. Several kinds of indexes have been designed.

A team of ARS scientists, including geneticist Steve A. Eberhardt and entomologist Wilbur D. Guthrie, compared a new, modified selection index with a conventional index in a study at Iowa State University, Ames. The team included graduate student Kriangsak Suwantaradon, agronomist James J. Mock, and entolomogist John C. Owens, of Iowa State.

The team recommends the modified selection index for simultaneous improvement of several heritable traits when the economic values of the traits are difficult to determine. By using the index with selected goals for each trait, a corn breeder could improve yield, increase seedling dry weight, improve emergence, increase root size for rootworm tolerance, obtain corn borer resistance, and give resistance to lodging—all at the same time.

Dr. Eberhardt says such a program could require as many as 14 cycles of selection. Although no single trait will improve as rapidly when selecting for it alone, neither will it likely limit hybrid performance.

The conventional index did not give satisfactory improvement of all traits in the study. Most improvement went into yield and seedling emergence—like getting a longer snake with two big loops.

New flax variety

FLAX VARIETIES that have been grown on 80 to 90 percent of the North American acreage are vulnerable to flax rust races 370 and 371, identified in 1973.

These varieties will be partly replaced in the 1976 growing season by the new variety Culbert, which is resistant to all known North American races of the disease. The name Culbert honors Dr. Joseph O. Culbertson, an ARS flax breeder, now retired, who was stationed at St. Paul, Minn., for many years.

The new variety carries the L^6 gene, which conditions immunity to all known North American races of flax rust, as well as the N^1 gene. Races 370 and 371, discovered and identified by ARS plant physiologist C. Dean Dybing, Brookings, S. Dak., and plant pathologist David E. Zimmer, Fargo, N. Dak., attack varieties with the N^1 or L and N^1 genes for rust resistance.

The scientists point out that use of resistant varieties will protect growers against losses from flax rust. In seasons favorable to development of rust, susceptible varieties may sustain moderate losses if planted early as recommended but may be heavily damaged by rust if planted late.

Culbert has been a high-yielding variety at principal flax-testing stations in the United States and Canada during the past 3 years. It is a medium-height, early-maturing variety adapted to the North Central production area.

The variety was developed through cooperative research by ARS and the Minnesota, North Dakota, and South Dakota Agricultural Experiment Stations. It was bred and selected at St. Paul by former ARS agronomist Verne E. Comstock.

When reporting research involving pesticides, this magazine does not imply that pesticide uses discussed have been registered. Registration is necessary before recommendation. Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if not handled or applied properly. Use all pesticides selectively and carefully.

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